IN THE CLAIMS

1. (Original) A method for quantum information processing comprising:

providing physical systems arranged in a resonator, each physical system having three energy levels, two transitions of three transitions between the three levels being optically allowed, wherein a quantum bit of each physical system is expressed by either of quantum states of two levels constituting a remaining optically forbidden transition or by their superposition state, and wherein at least two physical systems are included, one transition of the optically allowed two transitions being different in transition frequency for respective physical systems, and the at least two physical systems being coupled quantummechanically through a common resonator mode;

irradiating one physical system selectively with two kinds of light, frequency difference thereof corresponding to a transition frequency of the optically forbidden transition of the physical system, thereby setting an initial state;

irradiating the other physical system selectively with two kinds of light, frequency difference thereof corresponding to a transition frequency of the optically forbidden transition of the other physical system, thereby setting an initial state; and

irradiating the two physical systems simultaneously with two kinds of light, the two kinds of light having frequencies resonant with the optically allowed transitions other than the transitions coupled through the common resonator mode, while increasing an intensity level of one of the two kinds of light and decreasing an intensity level of the other light between start time and finish time of the simultaneous irradiation, thereby exchanging the quantum states between the two physical systems.

2. (Original) The method according to claim 1, wherein the physical systems are held in a solid substance, and wherein one transition of optically allowed two transitions is

different in transition frequency for respective physical systems according to a surrounding local field.

3. (Original) The method according to claim 1, wherein the physical systems consist of ions contained in a solid substance, and wherein two of the three energy levels of each physical system are neighboring two levels generated by hyperfine structure splitting due to the nuclear spin of the ion.

4. (Original) The method according to claim 1, wherein the physical systems include a plurality of physical system groups, each group including a plurality of physical systems whose transition frequencies are in a given range, and wherein the quantum states of the plurality of physical systems contained in each group are collectively changed.

5. (Original) The method according to claim 1, wherein the resonator is constituted by the surfaces of a solid substance containing the physical systems.

6. (Previously Presented) The method according to claim 1, wherein the states of the three energy levels of each physical system are set to $|0\rangle$, $|1\rangle$, and $|e\rangle$ in order from a lowest energy level, the $|0\rangle$-$|e\rangle$ transition and the $|1\rangle$-$|e\rangle$ transition being optically allowed, and wherein a quantum bit is expressed by the state $|0\rangle$, the state $|1\rangle$, or a superposition state thereof, the method further comprising:

in the case where the $|0\rangle$-$|e\rangle$ transitions of respective physical systems are coupled through a common resonator mode, irradiating the physical systems with light of a frequency resonant with the $|1\rangle$-$|e\rangle$ transitions while scanning the frequency thereof in a range in

which transition frequencies of the | 1>- | e> transitions of the physical systems are distributed, thereby effecting preprocessing for information processing; and

in the case where the | 1>- | e> transitions of respective physical systems are coupled through a common resonator mode, irradiating the physical systems with light of a frequency resonant with the | 0>- | e> transitions while scanning the frequency thereof in a range in which transition frequencies of the | 0>- | e> transitions of the physical systems are distributed, thereby effecting preprocessing for information processing.

7. (Original) The method according to claim 6, wherein assuming that a scanning range of a light frequency irradiated for the preprocessing is $\Delta\nu_{Bw}$, a central transition frequency of the | 0>-| 1> transitions is $\nu_{01center}$, and an inhomogeneous width of the | 0>- | 1> transitions is $\Delta\nu_{01inhomo}$, $\Delta\nu_{Bw}$ is set smaller than a value obtained by subtracting half of $\Delta\nu_{01inhomo}$ from $\Delta\nu_{01inhomo}$.

8. (Original) The method according to claim 1, wherein the physical systems are applied with a magnetic field or an electric field together with irradiation with light, and wherein levels subjected to splitting by breaking degeneracy of the two levels constituting the optically forbidden transition are utilized.

9. (Original) The method according to claim 1, wherein the information processing is a controlled-NOT operation.

10. (Original) The method according to claim 1, wherein computation is executed by combining the controlled-NOT operation and a one-quantum bit operation.

11. (Original) The method according to claim 10, wherein the one-quantum bit operation is performed by irradiating a physical system in a solid substance intended to change a quantum state with two kinds of light that resonate with optically allowed two transitions of the physical system, respectively.

12. (Original) The method according to claim 10, wherein the one-quantum bit operation is performed by irradiating a physical system in a solid substance intended to change a quantum state with two kinds of light that do not resonate with any of optically allowed two transitions of the physical system but two-photon resonate with a remaining optically forbidden transition.

13. (Original) The method according to claim 12, wherein the physical systems are irradiated with light resonant with one of the optically allowed two transitions, which does not resonate with the resonator mode, with scanning the frequency thereof, and emissions from the physical systems are detected, thereby reading-out the quantum states of respective physical systems.

14. (Previously Presented) A quantum information processor, comprising:

physical systems each having three energy levels, two transitions of three transitions between the three levels being optically allowed, wherein a quantum bit of each physical system is expressed by either of quantum states of two levels comprising a remaining optically forbidden transition or by a superposition state thereof, and wherein at least two physical systems are included, one transition of the optically allowed two transitions being different in transition frequency for respective physical systems, with the other transition of

the optically allowed two transitions being common in transition frequency for the respective physical systems;

a resonator provided around the physical systems and having a resonator mode that resonates with the transition common in transition frequency for the respective physical systems; and

a light source and an optical system configured to irradiate the physical systems with two kinds of light.

15. (Original) The quantum information processor according to claim 14, further comprising an electromagnet for applying a magnetic field to the physical systems.

16. (Currently Amended) The quantum information processor according to claim 14, wherein the optical system is configured to divide light from the light source into a plurality of optical paths, and wherein each optical path is provided with an ~~acoustooptic~~ acousto-optic device configured to control a frequency of the light from the light source and an ~~electrooptic~~ electro-optic device configured to generate a light pulse train.

17. (Original) The quantum information processor according to claim 14, wherein the light source and the optical system are configured to irradiate the physical systems with light while scanning the frequency thereof.

18. (Original) The quantum information processor according to claim 14, further comprising a photodetector configured to detect light emitted from the physical systems due to light irradiation to the physical systems.

19. (Previously Presented) The processor according to claim 14, wherein the two kinds of light have frequencies resonant with the optically allowed transitions other than the transitions coupled through the common resonator mode of selected two physical systems.